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Sleep Disorder Prevalence among Brazilian Children and Adolescents with Down Syndrome: An Observational Study

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Abstract: Background: Down syndrome (DS) is the most common chromosomal disorder and is related to congenital heart disease, sleep disorders and obesity. Sleep problems are common in DS children, including obstructive sleep apnea. This study aimed to investigate the prevalence of sleep disorders in a group of 41 DS children and adolescents, by two validated questionnaires. Methods: This is a qualitative observational study. The guardians of DS individuals (1–17 years old) answered two questionnaires (sleep questionnaire by Reimão and Lefévre–QRL and sleep disorders scale for children–SDSC) using the Google forms tool. Results: Most DS children wake up at least once during the night (68.28%), sleep during the day (56%) and fall asleep within 15 to 30 min (36.58%), urinate in the sleep at night (53.65%), move around a lot while sleeping at night (78.04) and snore at night (53.66%). In SDSC, 36.59% (n = 15) have some sleep disorder and 29.3% (n = 12) have sleep-disordered breathing. Conclusions: The DS children and adolescents present sleep-compromising factors. Moreover, obstructive sleep apnea is the most prevalent sleep-disordered breathing. Considering the findings of the current study, Google forms is an important tool to evaluate the sleep disorders of DS children and adolescents.

Keywords: down syndrome; children; sleep disorder; sleep breathing disorder; obstructive sleep apnea

Citation: Torres-Nunes, L.; da Costa-Borges, P.P.; Paineiras-Domingos, L.L.; Bachur, J.A.; de Sá-Caputo, D.d.C.; Bernardo-Filho, M. Sleep Disorder Prevalence among Brazilian Children and Adolescents with Down Syndrome: An Observational Study. *Appl. Sci.* **2023**, *13*, 4014. https://doi.org/10.3390/app13064014

Academic Editor: Raúl Quevedo-Blasco

Received: 31 January 2023
Revised: 13 March 2023
Accepted: 20 March 2023
Published: 21 March 2023

1. Introduction

Down syndrome (DS; trisomy 21) is the most common chromosomal disorder in humans [1], with an estimated annual incidence of one in 1000 live births worldwide [2]. It has numerous associated neurologic phenotypes, including intellectual disability, sleep apnea, seizures, behavioral problems and dementia [1]. DS is related to diseases such as obstructive sleep apnea (OSA), congenital heart disease, obesity and overweight [3].

Sleep problems have harmful psychological and physical effects [4], and have a bi-directional impact on daytime children performance, parental well-being, and overall family functioning in the general population, including in DS children [5]. Any sleep problem has the potential to exert significant negative effects on daytime behavior, learning and quality of life, and there is evidence that DS children are similarly affected [2].

Sleep problems are common in DS children, especially in school-aged children [2], including difficulty initiating and maintaining sleep along with OSA [2]. OSA and lower airway anomalies are both highly prevalent in DS children [6–8]. However, little is known about the interaction between the two [7]. Lee et al. [8] estimated the prevalence of OSA in

DS children and found a high prevalence, and that the prevalence of moderate-to-severe OSA is higher at a younger age.

OSA has adverse effects on the cardiovascular system, and this is a particularly significant issue given the high rates of hypertension and premature heart disease in DS people [2]. OSA was common despite previous surgery [9]. DS children have more unstable ventilatory control compared to typically developing children, contributing to an increased risk of sleep-disordered breathing [10].

Observational studies have been developed more frequently during the pandemic caused by COVID-19, justified by the impossibility of interventional approaches and lockdown [11–13]. Many of these studies were able to investigate behavioral aspects and the lifestyle of different populations, especially children and adolescents, such as physical activity and the quality of life in children [14], physical activity in students aged 17 years and older [15], oral hygiene of children between 4 and 7 years of age [16], physical activity and daily routine of children between 0 and 12 years of age [17], behavior of families focusing on children and adolescents [17] and sleep disorders in children [18,19], among others. In most of these studies, different tools, such as Google forms [11,12], have been shown to be effective and adequate for the dissemination and execution of the people (surveys), a significant participation of individuals and the collection of data.

Therefore, the aim of the current study was to investigate the prevalence of sleep disorders in a group of 41 DS children and adolescents in Brazil, by two validated questionnaires, through the Google forms tool. Through this, it will be possible to try to establish alternatives to aid improving the quality of sleep of DS children and adolescents, minimizing complications in the daily routine and preventing the appearance of more severe manifestations, such as OSA.

2. Materials and Methods

2.1. Ethics of Questions and Study Design

This is an observational study, consisting of anonymous electronic surveys. It was approved by the Ethics Committee of the Hospital Universitário Pedro Ernesto (HUPE), Universidade do Estado do Rio de Janeiro (UERJ), CAAE 30649620.1.0000.5259.

Two questionnaires (the sleep questionnaire by Reimão and Lefévre–QRL [20] and the sleep disturbance scale for children–SDSC [21]) were edited into an electronic form using the Google forms tool, and disseminated through social networks (https://docs.google.com/forms/d/1sAcdZ2PLdbWOcgJitRJP2rf1yViFLyUFYEfr9xlYzaQ accessed on 19 March 2023). All participants were identified by numbers to ensure the anonymity of responses. The researchers treated the identity of all participants in this study with a professional standards of secrecy, meeting the Brazilian legislation (Resolution No. 466/12 of the National Health Council), using the information only for academic and scientific purposes.

The questionnaires were distributed and accessed by a link sent through WhatsApp by the guardians of DS children and adolescents. The data collection occurred from 27 March 2021 to 17 July 2022.

The first page of the form had some information about the ethics data and relevant characteristics of this study conducted in the "Laboratório de Vibrações Mecânicas e Práticas Integrativas"—LAVIMPI, "Policlínica Universitária Piquet Carneiro", "Universidade do Estado do Rio de Janeiro"—UERJ. For participation and authorization of the use of data, a personal email was also required. The identity of the DS children and adolescents (age, gender, relation of respondent to child or adolescent, obesity, body mass index (BMI), daytime sleepiness, OSA diagnostic) were recorded. The guardians answered the questionnaires, and the information was kept confidential, generating a unique code for each participant. the participants could withdraw from completing the research without any penalty or restriction at any time, as stated in the Declaration of Helsinki, which contains ethical principles for medical research involving human subjects.

2.2. Participants

A total of 41 guardians of DS children and adolescents answered the surveys, QRL [20] and SDSC [21]. The DS children and adolescents, aged 1 to 17 years, whose guardian agreed to answer the questions in the questionnaires, were included. The DS children and adolescents who live outside Brazil were excluded.

2.3. Technical Information about the Sleep Disturbance Assessment Tools

The sleep questionnaire by Reimão and Lefévre (QRL) helps guide the diagnosis of sleep disorders and characterize the habits and sleep patterns of young children [20].

The QRL [20] considers the behavior of sleep patterns in the last 12 months and is divided into 4 parts: patient identification, sleep pattern assessment, sleep habits assessment and the presence of sleep disorders. The questionnaire includes the purpose description item, multiple-choice questions for some sleep disorders, number of hours slept and frequency of occurrence of sleep disorders. This questionnaire allows for establishing quantitative and qualitative indicators, but it is not possible to obtain a final score [20]. It was developed as a scientific literary resource that could be widely used for the research of prevalence of sleep disorders in the Brazilian infant population.

The psychometric evaluation of this instrument was presented by Cavalheiro et al. [22]. In it, the authors describe the whole validation process of this instrument.

The sleep disturbance scale for children (SDSC) questionnaire appears to be a useful tool in evaluating the sleep disturbances of school-age children, including DS children [21]. The SDSC [21] consists of 26 questions and investigates sleep behavior in the last six months. The questions are divided into 6 factors: factor 1—sleep initiation and maintenance disorders (DIMS); factor 2—sleep-disordered breathing (SDB); factor 3—arousal disorders (ADD); factor 4—sleep–wake transition disorders (DSWT); factor 5—excessive daytime sleepiness disorders (EDS); factor 6—sleep hyperhidrosis (HS). Responses are reported on a five-point scale as follows: 1 (never), 2 (occasionally), 3 (sometimes), 4 (almost always), 5 (always). Each factor has its score and sum, and the sum of all factors will show the total score. DIMS above 21 points, SDB above 6 points, ADD above 11 points, DSWT above 23 points, EDS above 19 points and HS above 7 points were considered. For the child to be considered as having a sleep disorder, the total score must be above 69 points.

2.4. Statistical Analysis

For the sample calculation, the formula described by Miot et al., 2011 [23], was used, considering quantitative variables and an infinite population. Using the total score of the "children's sleep habits questionnaire" [24], with an average of 47.51 and standard deviation of 6.91, a power of 95% at an alpha = 0.05, the sample size was calculated as 32. The GraphPad Prism 6.0 statistical package was selected to carry out the analysis.

The answers of the participants were protected, whereby the data were recorded and scored in electronic spreadsheets by customized Excel formulas for further analysis.

Descriptive statistical analyses were performed and characterized as *n* (%), through data exported to Excel referring to QRL and SDSC responses.

The answers referring to the QRL were analyzed qualitatively and quantitatively, accounting for the total number of responses, followed by the corresponding percentage (%).

The nonparametric Spearman correlation (r) was used to analyze the SBD responses, age and obesity.

3. Results

A total of 41 QRLs [20] and 41 SDSCs [21] were answered through Google forms. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) [25] was used to guide this cross-sectional study. Figure 1 shows the detailed development of this study through the STROBE flowchart.

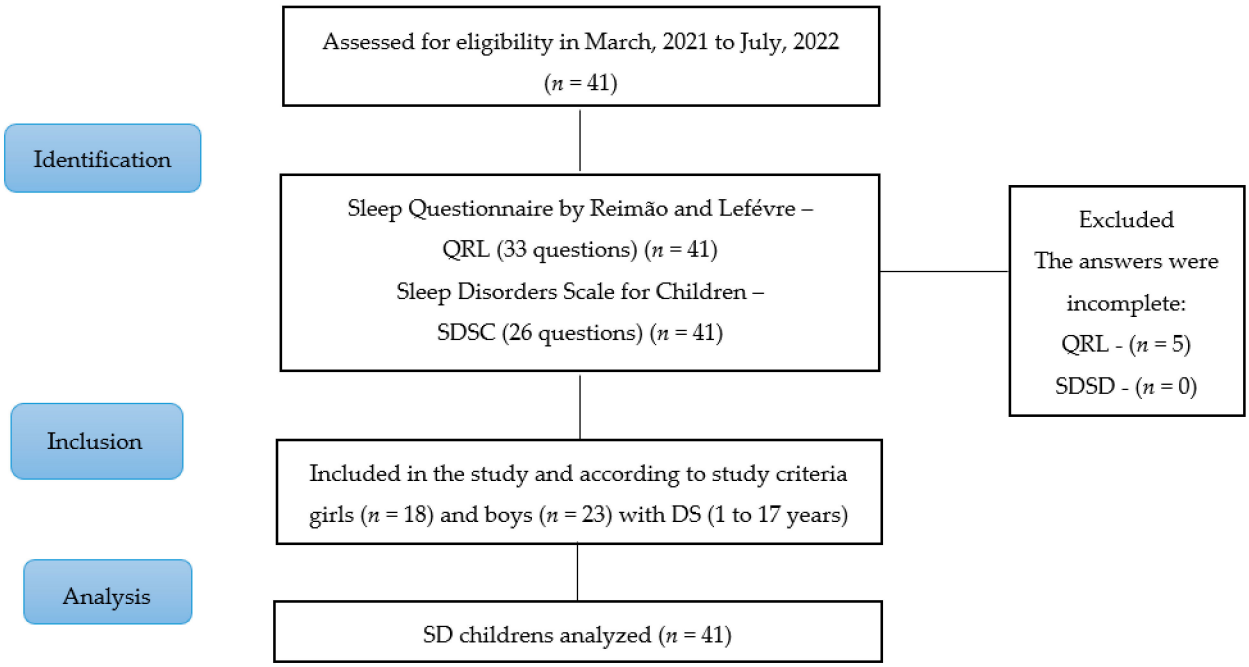


Figure 1. Flowchart of the study.

Table 1 presents the most relevant characteristics of the DS children and adolescents of the current study (n = 41). The information was provided by the guardians of the DS children and adolescents during the completion of the form on personal data.

Table 1. DS child and adolescent characteristics.

Gender	Girls (18) 43.90%, age range 1–14 years Boys (23) 56.09%, age range 1–17 years
Age (years)	1–3 (17) 41.46%
	4–6 (16) 39.02%
	7–9 (3) 7.31%
	10–12 (3) 7.31%
	14–17(2) 4.87%
Relation of respondent to child or adolescent	Mother (40) 97.56% Father (1) 2.43%
Obesity (BMI $\geq$ 30)	(3) 7.31%
Daytime sleepiness	(23) 56.09%
OSA diagnostic	Yes (9) 21.95% Unaware of the diagnosis (12) 29.26%

BMI—body mass index; OSA—obstructive sleep apnea. (%) percentage.

Table 2 presents a profile of the population investigated through the QRL. The number (n) of participants in each category is shown between parentheses, followed by the corresponding percentage (%). The total sample of DS children and adolescents is 41. Regarding the prevalence of the sleep behavior, it is possible to verify that most children (36.58%) wake up at least once during the night, sleep during the day (56%) and fall asleep within 15 to 30 min (36.58%).

Table 2. Profile of the 41 Brazilian DS children and adolescents through the QRL.

Sleep during the day?	Yes	No				
	(23) 56%	(18) 44%				
How many hours does the child sleep during the day?	40 min	1 h up to 1 h and 40 min	2 h or 2 h and 30 min	3 h		
	(1) 2.44%	(10) 4.1%	(9) 21.95%	(1) 2.44%		
How often does the child get up during the night?	does not wake up during the night	wakes up once during the night	wakes up twice during the night	wakes up three times a night	wakes up five times during the night	wakes up more than five times during the night
	(11) 26.82%	(15) 36.58%	(8) 19.51%	(3) 7.31%	(1) 2.44%	(1) 2.44%
Total hours of sleep during the night?	6 h and 30 min	8 h/ 8 h and 30 min	9 h/ 9 h and 30 min	10 h/ 10 h and 30 min	11 h	12 h
	(1) 2.44%	(5) 12.19%	(4) 9.75%	(17) 41.46%	(7) 17.07%	(4) 9.75%
How long does it take the child to fall asleep?	5 min or less	between 5 and 15 min	between 15 and 30 min	more than 30 min		
	(4) 9.75%	(12) 29.26%	(15) 36.58%	(10) 24.39%		
When waking up during the night, how long does it take for the child to fall asleep again?	does not wake up during the night	5 min or less to sleep	between 5 and 15 min to sleep	between 15 and 30 min to sleep	more than 30 min to sleep	
	(7) 17.07%	(17) 41.46%	(7) 17.07%	(5) 12.19%	(5) 12.19%	
What usually arouses the child?	wakes up alone	desire to go to the bathroom	noises	family	pet	
	(33) 80.48%	(2) 4.87%	(2) 4.87%	(3) 7.31%	(1) 2.43%	
During the day, does the child presents drowsiness that interferes?	does not present	school activities	sports practice	watch television		
	(34) 82.92%	(5) 12.19%	(1) 2,43%	(1) 2.43%		

Table 3 shows the answers referring to the sleep pattern and presence of sleep disorders, obtaining information about the structural, temporal and physiological organization of the sleep–wake cycle. The number (*n*) of participants in each category is shown between parentheses, followed by the corresponding percentage (%). The total sample is 41 DS children.

Table 3. Sleep pattern assessment and presence of sleep disorders.

	Everyday	**One Time per Week**	**One Time per Month**	**Less than 1 Time per Month**	**Never Happens**
Urinates while sleeping at night	(22) 53.65%	(3) 7.31%	(2) 4.87%	(2) 4.87%	(12) 29.26%
Urinates while sleeping during the day	(17) 41.46%	(2) 4.87%	(2) 4.87%	(2) 4.87%	(18) 43.90%
Talks while sleeping	(1) 2.43%	(10) 24.39%	(2) 4.87%	(5) 12.209%	(23) 56.10%
Grinds teeth while sleeping	(3) 7.31%	(8) 19.51%	(3) 7.31%	(2) 4.87%	(25) 60.97%

Table 3. *Cont.*

	Everyday	One Time per Week	One Time per Month	Less than 1 Time per Month	Never Happens
Moves a lot in bed while sleeping	(32) 78.04%	(3) 7.31%	(0)	(0)	(6) 14.63%
Screams for no reason while sleeping	(0)	(3) 7.31%	(4) 9.75%	(5) 12.19%	(29) 70.73%
Says that they had bad dreams and that they are afraid	(1) 2.43%	(0)	(3) 7.31%	(6) 14.63%	(31) 75.60%
Snoring at night	(11) 26.82%	(4) 9.75%	(5) 12.19%	(2) 4.87%	(19) 46.34%
Snoring during the day	(3) 7.31%	(1) 2.43%	(5) 12.19%	(2) 4.87%	(30) 73.17%
Taps and shakes head with equal movements many times in a row in bed	(2) 4.87%	(3) 7.31%	(4) 9.75%	(1) 2.43%	(31) 75.60%
Has difficulty staying awake during morning activities	(0)	(2) 4.87%	(3) 7.31%	(4) 9.75%	(32) 78.04%
Has difficulty staying awake during afternoon activities	(2) 4.87%	(3) 7.31%	(2) 4.87%	(4) 9.75%	(30) 73.17%

It is possible to verify that most DS children and adolescents urinate in their sleep at night (53.65%), move around a lot while sleeping at night (78.04) and snore at night (53.66%).

Table 4 shows the answers referring to sleep habits, with the total number of yes or no answers for each question and between parentheses, according to gender.

Table 4. Sleep habits assessment.

	Yes	No
Sleeps with pet	0	41 (18 girls, 23 boys)
Sleeps with a doll, toy or stuffed animal	9 (7 girls, 2 boys)	32 (11 girls, 21 boys)
Prefers light on to sleep	6 (5 girls, 1 boy)	35 (13 girls, 22 boys)
Only sleeps if the bedroom light is on	4 (2 girls, 2 boys)	37 (16 girls, 21 boys)
If they did not have to wake up, would sleep longer every day	9 (6 girls, 3 boys)	32 (12 girls, 20 boys)
Have been to the doctor for having problems sleeping	5 (2 girls, 3 boys)	36 (16 girls, 20 boys)
Sleeps at school	3 (3 boys)	38 (18 girls, 20 boys)
Why does the child sleep at school?	was not informed	

It is possible to verify that no child sleeps with a pet, most DS children and adolescents do not sleep with toys, do not sleep with the light on and most children have never been to the doctor because of sleep problems.

SDSC

The SDSC questionnaire is divided into six factors and summarizes the score of specific questions for each factor: factor 1 (DIMS– questions 1, 2, 3, 4, 5, 10 and 11); factor 2 (SDB—questions 13, 14 and 15); factor 3 (ADD—questions 17, 20 and 21); factor 4 (DSWT—questions 6, 7, 8, 12, 18 and 19); factor 5 (EDS—questions 22, 23, 24, 25 and 26); factor 6 (HS—questions 9 and 16). The total score is the sum of the scores for all questions. The sleep behavior is considered modified when: the DIMS is above 21 points, SDB is above 6 points, ADD is above 11 points, DSWT is above 23 points, EDS is above 19 points and HS is above 7 points. For the child to be considered as having a sleep disorder, the total score must be above 69 points. Table 5 shows each the child score for the SDSC factors.

Table 5. SDSC factor score.

Participant Code	DIMS	SDB	ADD	DSWT	EDS	HS	TS
P01	9	3	7	12	7	3	41
P02	20	4	4	16	7	3	54
P03	19	6	9	10	23	6	73
P04	14	6	4	11	8	6	49
P05	21	15	7	19	5	4	71
P06	9	4	3	8	6	2	32
P07	20	7	3	16	7	6	59
P08	17	15	5	11	10	5	63
P09	9	3	3	7	5	2	29
P10	16	8	7	17	6	6	60
P11	14	6	7	16	9	10	2
P12	18	3	4	8	6	2	41
P13	9	3	5	12	10	2	41
P14	9	4	3	7	5	3	31
P15	11	4	4	10	5	2	36
P16	18	3	4	9	8	4	46
P17	16	14	6	14	6	6	62
P18	11	3	3	10	6	2	35
P19	27	8	6	9	6	2	58
P20	12	4	5	13	7	4	45
P21	11	5	5	13	5	5	44
P22	32	3	4	10	17	2	68
P23	20	7	6	21	9	2	65
P24	23	8	7	11	7	5	61
P25	14	4	5	11	5	4	43
P26	13	3	6	13	5	2	42
P27	9	13	6	16	9	3	56
P28	8	3	4	6	5	2	28
P29	8	3	3	7	5	4	30
P30	17	12	3	14	10	2	58
P31	19	5	7	17	6	2	56
P32	11	4	4	10	6	4	39
P33	8	9	4	12	7	2	42
P34	7	3	3	8	6	2	29
P35	9	5	3	9	6	3	35
P36	11	5	4	10	6	2	38
P37	7	6	6	15	5	2	41
P38	16	5	5	13	6	5	50
P39	7	3	3	6	5	2	26
P40	8	3	7	15	5	2	40
P41	21	15	7	11	14	2	70

DIMS—sleep initiation and maintenance disorders; SDB—sleep-disordered breathing; ADD—arousal disorders; DSWT—sleep–wake transition disorders; EDS—excessive daytime sleepiness disorders; HS—sleep hyperhidrosis; TS—total score.

In Table 5, DIMS > 21 was observed in 3 (7.31%) DS children and adolescents, SDB > 12 was observed in 12 (29.26%) DS children, one DS child had EDS > 19 points, one DS child scored > 7 in HDS. A total of 15 (36.58%) DS children were above the threshold for at least one factor. Overall, 3 (7.31%) DS children scored higher than 69 points and were considered to have sleep disorders. No child showed higher ADD and DSWT scores.

Figure 2 shows the results of the SDSC in a percentage chart, considering: DS children and adolescents without sleep disorders and with some sleep disorders. According to the SDSC (total score = 69), it is possible to verify that 92.68% (n = 38) of the DS children and adolescents are not considered to have sleep disorders. However, it is necessary to verify the percentage of DS children and adolescents who had a score above 69, confirming the sleep disorders, and 36.59% (n = 15) who showed a higher score of at least one evaluated factor, suitably showing the type of sleep disorder presented.

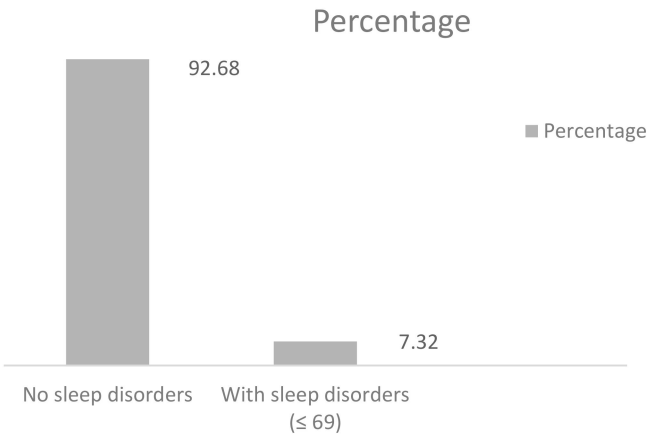


Figure 2. Sleep disorder profile by SDSC (%).

Figure 3 shows the relative percentage (%) of each sleep disturbance factor and the total score of the SDSC. It is also possible to verify that the factor that presented the highest percentage was the SDB, with 29.3% (*n* = 12) of the DS children and adolescents investigated.

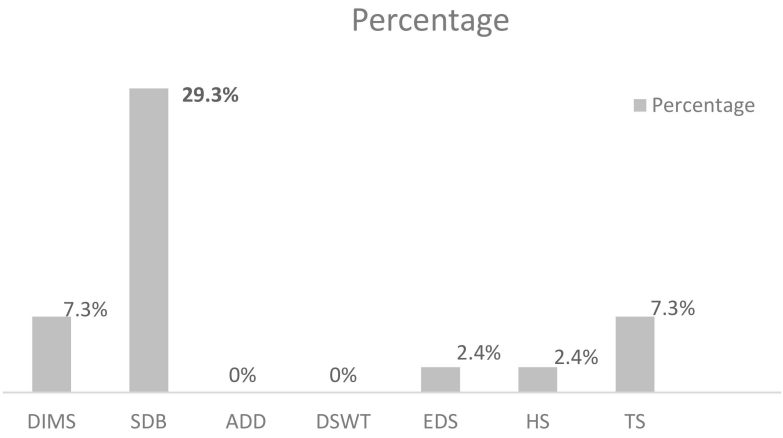
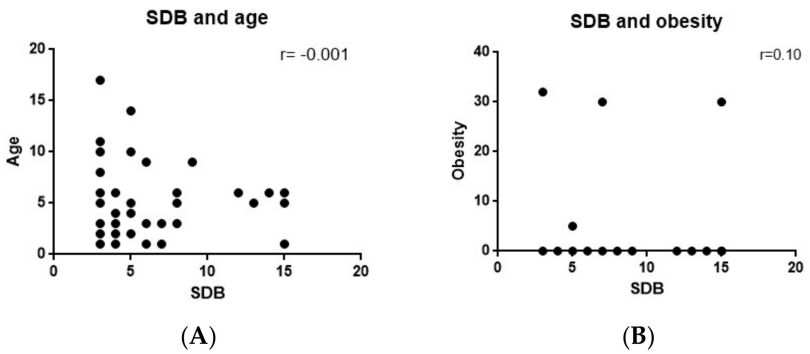


Figure 3. Percentage (%) of each SDSC factor and the score total. DIMS—sleep initiation and maintenance disorders; SDB—sleep-disordered breathing; ADD—arousal disorders; DSWT—sleep–Wake transition disorders; EDS—excessive day-time sleepiness disorders; HS—sleep hyperhidrosis; TS—total score. The data are expressed in absolute numbers (*n*) and in percentage (%).

A correlation analysis was made between the results of the SDB item, age and obesity of DS children and adolescents (Figure 4A,B), using the Spearman nonparametric test. No correlations were found between the SBD and the variables analyzed (r = −0.001 and r = 0.10). Only 3 DS children and adolescents had obesity (BMI ≥ 30).



(**A**) (**B**)

Figure 4. Spearman correlation. (**A**) SDB × age, (**B**) SDB × obesity. SDB—sleep-disordered breathing.

4. Discussion

Sleep, its quality and the disorders presented during sleep, have been the object of investigation in different populations [26,27], but it is not strongly studied in DS individuals. To the best of our knowledge, this is the first study to report the prevalence of sleep problems in Brazilian DS children and adolescents. In the current study, the quality and sleep pattern of 41 DS children and adolescents was evaluated, determining the prevalence of them. Of the DS children and adolescents investigated, most males, 68.28% presented indications of sleepiness during the day, movements during night sleep and need to wake up during night sleep by the QRL questionnaire. We also found data related to the habit of peeing during sleep in this observational study. Across the SDSC applied in this current cross-sectional study, 15 children showed an increase in the score of at least one factor, while only three DS children and adolescents had above 69 points of the total score, suggesting that they had sleep disorders.

In DS individuals, sleep disorders have shown a significant prevalence [9], and especially in children, sleep is an important and dynamic process, affecting numerous aspects of health and development such as physical, behavioral, and physiological development, and poses an additional risk for obesity, endocrine disorders, depression, immunological and heart diseases [28].

As it was done in the current observational study, Chawla et al. [29] conducted semi-structured interviews with 34 parents, with open-ended questions about parents' experiences with sleep, family dynamics and health care. Parents normalized their experiences of having a DS child and sleep problems. Parents recognized that sleep disruption had adverse and pervasive impacts on their well-being and family dynamics, but they also found it difficult to identify this as a health issue.

4.1. QRL Outcomes

Regarding QRL responses, analyzing the prevalence of sleep behavior issues and considering all the QRL responses, we can affirm that these findings of the current observational study agree with Fucà et al. [30]. While our study pointed the sleepiness during the day, movements during night sleep and the need to wake up during night sleep as most sleep behavior problems, Fucà et al. [30] concluded that in addition to OSA, several other sleep difficulties have been reported in DS children, such as delayed sleep onset, night awakenings and morning awakenings.

Particularly, with COVID-19 being a risk factor for the worsening of the respiratory conditions of the DS children, Gios et al. [31] investigated the sleep characteristics and the changes in daily habits resulting from the COVID-19 pandemic, during social isolation, between Brazilian children and adolescents (4–12 years) with autism spectrum disorder, DS and typical development. On average, DS children's bedtime occurred one hour later during the pandemic. The DS children showed a great number of sleep alterations only in the domain of respiratory disorders, and some clinical characteristics, such as metabolic, endocrine, anatomical and neurological disorders contributed to the pathophysiology of OSA. The authors concluded the prevalence of this disorder to be high in this population, with critical consequences in terms of quality of health and life.

4.2. Sleep Disorders Most Prevalence

The most prevalent sleep disorders found among DS children and adolescents investigated in the current study were the DIMS and SDB, commonly related to OSA in DS children.

Regarding the DIMS factor, the findings of the current study are in agreement with Rosen et al. [19] These authors declared that DS children have increased difficulty initiating and maintaining sleep (DIMS), excessive daytime sleepiness (EDS) and OSA. Additionally, Churchill et al. [32] concluded that sleep disturbances are negatively related to accomplishment of daily life functions, and prevention and treatment of sleep problems, particularly

sleep-disordered breathing, may lead to enhanced accomplishment of daily life habits and activities in DS children.

DS children with sleep-breathing disorders have impairments in ventilatory control. Siriwardhana et al. [10] claimed this after investigating the role of ventilatory control instability (i.e., loop gain) in DS children (3–19 years), compared with typically developing children matched for age, sex and sleep-disordered breathing severity. All children underwent overnight polysomnography. Higher loop gain in these DS children indicated that they have more unstable ventilatory control. This may be due to an inherent impairment in ventilatory control in DS children, contributing to their increased risk of sleep-disordered breathing, which may inform alternative treatment options for this population.

Skoto et al. [33] reinforced that detecting OSA is important to both prevent significant comorbidities in DS people and untangle contributions to other behavioral and mental health diagnoses. DS children are vulnerable to OSA because of their unique and hypotonic craniofacial anatomy [34,35]. However, there is a paucity of information on the optimal management of OSA in DS.

Maris et al. [36] assessed the prevalence of OSA in a large cohort of DS children and concluded that in children with parental reports of snoring or witnessed apneas, OSA was significantly more common (75.7%) and more severe than in those without these symptoms (53.8%). Based on overnight polysomnography, an overall prevalence of 66.4% of OSA was found in DS children. Younger age was associated with more severe disease.

Hill et al. [35] recruited 202 DS children (5–6 years; 110 boys). Clinical evaluation was done, including the height, body mass, tonsillar size and cardiorespiratory polygraphy. Moderate-to-severe OSA was found in 14%, and mild-to-moderate OSA was found in 59% of 188 DS child participants. Male gender and habitual snoring predicted OSA, and moderate-to-severe OSA was common in very young DS children.

Horne et al. [2] showed that the sleep problems in DS children have been reported by parents in up to 65% of school-aged children, with rates significantly higher than in typically developing (TD) children. In addition to adverse effects on daytime functioning, OSA has adverse effects on the cardiovascular system, increasing the risk of hypertension and early heart disease in DS people, requiring effective treatment to improve the quality of life of these children.

Stores et al. [37] considered that the investigation for sleep disorders and their causes should be routine, and that positive findings require a detailed diagnosis. It is necessary to recognize the likely multifactorial etiology of sleep disorders in DS children. Successful treatment can be expected to significantly alleviate difficulties for both the child and the family.

In the end, encouraging the practice of physical activity is highly recommended for DS children, which, among many benefits, helps improve the quality of sleep. Torres-Nunes et al. [38] published a case report signaling the effect of systemic vibration therapy on sleep in a DS child. As a preliminary result, Torres-Nunes et al. [38] found that after two sessions of systemic vibration therapy, a child stopped urinating during naps, woke up in morning in less than 15 min, was not late for school due to oversleeping, had no problem staying awake at school in the morning and did not feel like sleeping more, in addition to a decrease in the score of DIMS, ADD and EDS.

The strength of this work was to observe the sleep disorders of Brazilian DS children and their prevalence, using two validated questionnaires accessed by the Google forms tool. To date, there are no articles with DS population evaluating in this way.

As limitations of this study, the authors state that this is a convenience sample, contemplated by DS children's guardians, who share information, doubts and guidance related to the management of these DS children in a same social group (WhatsApp) and were available to participate in the research. Another limitation is related to the analysis of the SDSC questionnaire, specifically in the investigation of the respiratory component evaluated as a sleep disorder factor. In this area, participants answer whether the DS child had a respiratory impairment, but there was no determination of whether this impairment

was related to central apnea syndromes, OSA or sleep-related hypoventilation/hypoxemia syndromes. This makes the data limited for carrying out a deeper analysis of the prevalence of OSA. Furthermore, the sleep questionnaires used in this study, although validated in Brazil, are not specific for DS children. In fact, a specific sleep questionnaire for DS children was not found in the literature. DS children have some peculiarities, some were exposed in this study, so it would be important to create a specific questionnaire to investigate sleep disorders in DS children.

5. Conclusions

The use of the Google forms to answer surveys about the quality of sleep of DS children seems to be a feasible tool. The questionnaires allowed for identifying the most prevalent sleep problems and disorders. Late onset of sleep and nocturnal awakenings appeared as a sleep impairment. Sleep-disordered breathing/OSA were also reported by the guardians of DS children and adolescents as the most prevalent disorders.

Author Contributions: Conceptualization, L.T.-N. and L.L.P.-D.; Methodology, L.T.-N., L.L.P.-D., P.P.d.C.-B. and J.A.B.; Formal Analysis, L.T.-N. and J.A.B.; Investigation, L.T.-N., P.P.d.C.-B., L.L.P.-D. and J.A.B.; Resources, L.T.-N., P.P.d.C.-B., L.L.P.-D. and J.A.B.; Data Curation, L.T.-N. and J.A.B.; Writing—Original Draft Preparation, L.T.-N., P.P.d.C.-B. and L.L.P.-D.; Writing—Review and Editing, L.T.-N., P.P.d.C.-B., L.L.P.-D., J.A.B., D.d.C.d.S.-C. and M.B.-F.; Visualization, L.T.-N. and L.L.P.-D.; Supervision and Project Administration, D.d.C.d.S.-C. and M.B.-F. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), the Fundação de Amparo à Pesquisa do Estado do Rio de Janeiro (FAPERJ) and the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior—Brazil (CAPES)—Finance Code 001.

Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki, and approved on 20 April 2020, by the Institutional Review Board (or Ethics Committee) of the Hospital Universitário Pedro Ernesto (HUPE), Universidade do Estado do Rio de Janeiro (UERJ), with the protocol number CAAE 30649620.1.0000.5259.), and approved by the Ethics Committee of the Pedro Ernesto University Hospital, registered under number 30649620.1.0000.5259.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data are available on request from the corresponding author due to restrictions, e.g., privacy or ethics.

Acknowledgments: The authors of this study thank the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), ao Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) and Fundação Carlos Chagas Filho de Amparo a Pesquisa do Estado do Rio de Janeiro (FAPERJ) for funding support. These funding institutions had no role in designing or conducting this research.

Conflicts of Interest: No conflict of interest have been identified by any of the authors.

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